

Development of a Smart Ring Series using Kansei Engineering

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Abstract: People have become more flexible and healthier by using these smart devices to track and do their daily work. Exercises and daily activity management are key factors in a human's daily life. After analysing humans' issues and difficulties, the authors decided to develop an automated device. The researchers aim to develop a smart ring series with different features embedded in them to make the life of humans easy. Some people do not like to wear watches. However, almost all humans, especially females, love to wear rings. So, the authors decided that a ring would be more efficient and user-friendly. After the study, the authors decided to design a ring series as it would be easy for users. They can choose the ring with the feature they need rather than buying all the rings. The authors designed four rings. The first ring is capable of tracking your fitness level. The other ring can be used to lock and unlock your belongings. The third ring can be used to track your emotions, while the last ring is capable of tracking motion. Each ring has a particular feature along with the relevant sensors needed to accomplish the task. The authors have conducted a survey to find the relevant features and have followed Kansei Engineering concepts when designing the final design. The authors have designed the final design by conducting a statistical analysis of the results.

Keywords: Smart Ring Series, Kansei Engineering, Ring, Sensors

1. Introduction

With the increase in the usage of mobile devices in the past two years, people have also shown higher interest in using smart devices to make their work easier. With the development of technology, people use various smart devices to make their daily activities easily. The smart ring is a very unique and small device that can be used at any time without any hazard. If users use a smart ring, it can also be used as a fashion accessory. Also, by the initial studies, authors have recognized that it will be more useful if the authors develop a series of rings, each with one feature, because it will help the user accomplish the dedicated task quickly and efficiently.

In the past, humans used small reminders to track and ensure they don't miss any of the work they were supposed to complete. Also, they had no method of finding out about their physical fitness level or other health factors. With the improvement of technology and smart devices, users can

easily use them to accomplish these activities. Also, since the authors are developing a series of smart rings, each with a dedicated activity, the user can decide what features they need and buy the relevant ring.

In the early days, people used different manual locking systems to keep the doors and windows locked. Some of the mechanisms use keys to lock them, padlocks, wood locks, and many other mechanisms. Also, humans in the past did not have any way to check their pressure, blood oxygen, and other physical monitoring. The only way for them to do a health checkup is by either going to a government hospital and waiting in queues and getting it done or getting it from a private hospital. Also, they did not have any mechanism to track their motions like sleeping, walking or sitting. Tracking relevant motions will help an individual maintain a correct posture. The other most important factor is the detection of emotions. There was no mechanism in the past to detect emotions and provide solutions. Early detection of emotions will help to find out physiological diseases in humans.

When considering the drawbacks and loopholes in the traditional system, the authors designed a series of rings which will be able to accomplish several tasks that are important for humans. The authors have selected four features in our ring series with in-depth studies and analysis. They can be stated as; Heart Rate, Blood Oxygen Tracking, Temperature and tracking the calories burned, Unlock the smartphone or tablet and also lock and unlocking doors, Tracking emotions and feelings specially the stress level and Tracking movements such as sleeping, walking and sitting.

The Kansei Engineering method was used for this project. Authors have applied the Kansei Engineering procedure as follows; Drawing images of the proposed Smart Ring System, Evaluating the designs with respect to the Kansei Engineering method, Performing statistical analysis of the evaluated data, With according to the results obtained through analysis, and manufacturing the basic model of the series, Evaluated the product by choosing different domains and carried out an analysis upon the evaluated data and The final step is the development of the Smart Ring Series. As mentioned above, the series of rings have been differentiated according to four selected features that appear most important. The research aims to design and develop a series of smart rings with different embedded features.

The paper is structured as the literature review, methodology, results, discussion, conclusion and further work. The literature review will briefly describe the previously designed systems while the methodology will provide how the research was carried out. The results will give a brief description of the outcomes of the survey. The discussion consists of a comparison between the existing systems and the proposed system.

2. Literature Review

The literature review describes the rings and smart systems implemented before. The authors have referred to some of the previously developed rings. They have compared the features of those rings, decided the research gaps, and proposed a suitable ring to be designed.

A. Oura Ring

This is made up of ceramic and tracks the wearer's daily activities. Also, it will monitor your sleeping patterns and give suggestions to manage your activities. (Heli Koskimäki, 2018)

B. Motive Ring

This ring comes in eight different sizes enabling it to fit almost all finger sizes. This ring is waterproof and has a battery capacity lasting about five days. The main purpose of this is to track the physical fitness of the person wearing it. (James W. Navalta, 2020)

C. Ringly

This ring comes in eight different sizes enabling it to fit almost all finger sizes. This ring is waterproof and has a battery capacity lasting about five days. The main purpose of this is to track the physical fitness of the person wearing it. (Pringle)

D. Go2Sleep

This consists of a three-axis feature in order to detect sleeping patterns as well as the SpO₂ level of the person. This has a unique sleep detection option that keeps track of the turnings and tossing in the sleep. (Milad Asgari Mehrabadi, 2020)

E. ArcX

This ring focuses purely on the user's fitness, and it is friendly with any Operating System along with the iOS. Also, the battery capacity of the ring can last for about five days once given a full charge. (Bianchi & Je, 2017)

F. Movano ring

This is the most recently developed smart ring. It has a bold design, it is not that thick, and also it is very easy while wearing the ring. The main object of this is also to track the physical fitness and the health status of the person. It is capable of tracking blood oxygen level, body temperature, and heart rate and also, like almost all rings, it can also track sleeping patterns and the amount of sleep received by the person wearing it. (Partheniadis & Stavrakis, n.d.)

Table 1 will give a comparison of the features of the existing systems. The feature called 'Fitness Tracker'

consists of many areas such as SpO₂ level, Heart Rate, Blood Pressure and Calories burnt.

Table 1: Comparison of existing systems

Name of the ring	Fitness Tracker	Sleep Tracker	Waterproof	Alerts	Phone calls	Emergency mode
Oura	×	×				
Motiv	×		×			
Ringly				×		
Go2Sleep	×	×				
ArcX	×			×	×	×
Movano	×					

3. Methodology

The Kansei Engineering Methodology was used as the basic design approach for this proposed product. The following are the main phases the team took when doing the statistical analysis for Kansei Engineering. (Nagamachi M, 2008), (Gamage TA et al, 2021)(Kalhari A et al, 2020) Over the past few years, Japan has invented groundbreaking products before any other country. The foundation upon which all of their technology solutions are based on the understanding of the implicit consumer desires, or Kansei Engineering. A variety of instruments or methods from numerous disciplines, including psychology, marketing, and statistics, are utilized to put Kansei Engineering into practice. The foundation of KE investigations is the integration of quantitative and qualitative research techniques. Figure 1 will depict the flow of Kansei Engineering.

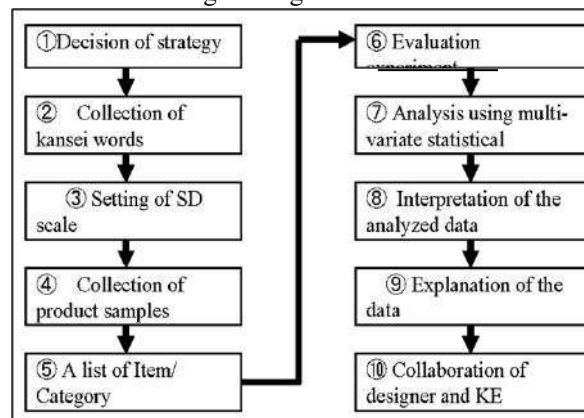


Figure 1 Flow of Kansei Engineering

The steps of Kansei Engineering can be defined as, Collecting Kansei words by studying literature reviews, Creating a survey and a 7-point rating system for the words that were identified, Analysing the Kansei words using a predefined group of individuals, Statistical evaluation of the data gathered, Choosing the features that will best address the words with high ratings, Analysing the outlined features using the defined group of persons, Conduct statistical analysis of the results and Working together with designers to represent the outcomes.

4. Results

Kansei Engineering consists of several steps: the selection of suitable kansei engineering words, the kansei evaluation experiment and the statistical procedure. The

Kansei evaluation consists of the evaluation given for design samples by the participants, while the statistical procedure analyses the relationship between Kansei words and design elements.

A. The Collection of Kansei Words

The 15 terms that have been compiled into a new database for the smart ring series are shown in Table 2.

Table 2: KE Words

User Friendly	Durable	Cheap	Handy	Fashionable
Decent	Efficient	Reliable	Security	Privacy
Comfortable	Reusability	Attractive	Flexible	Customizable

It is important to select words that highlight the customer's needs and that will also relate with the product to help us make proposals to satisfy the needs.

B. Weighting

After selecting the words with the highest grades and weights, a separate table with those words was made. Table 3 will provide the corresponding grades and weights of the words. Table 4 will consist of the five words that the team has chosen.

Table 3: Grade and Weighing of KE

Kansei word	Grade	Weight
User Friendly	60	0.50
Durable	110	0.79
Cheap	94	0.67
Handy	80	0.57
Fashionable	88	0.83
Decent	100	0.71
Efficient	99	0.71
Reliable	108	0.77
Security	105	0.75
Privacy	55	0.39
Comfortable	75	0.54
Reusability	70	0.50
Attractive	67	0.48
Flexible	50	0.36
Customizable	40	0.29

Table 4: Meanings

No	Kansei words	Meaning	Positively correlated to KW	Negatively correlated to KW
Word 1	Durable	Should be able to use for a long period without any damage or failure.	-everlasting -strong -permanent	-synthetic -breakable
Word 2	Decent	Should not consist of various unwanted designs	-Nice -Simple	-Fancy -overattractive
Word 3	comfortable	Should be able to wear it without difficulties	-good -pleasant	uncomfortable -hard
Word 4	Reliable	Results should be accurate and should be in good quality	-accurate -trustworthy	-loophole untrustworthy -uncertain
Word 5	Security	Should protect the data stored in it.	-protection -concealment	-Threats -vulnerabilities

C. Relating Kansei Engineering with Engineering Characteristics

Some characteristics are identified using Kansei Engineering words, and the words and the elements were combined in a questionnaire. Each question consists of a requirement which is related to the KE words. The questionnaire consists of two parts, functional and nonfunctional, to check the requirements of the Smart Ring Series. Table 5 depicts the example of the functional questions. The questionnaire was distributed among 30 participants.

Table 5: Functional requirements in the Questionnaire

Smart ring Series Shape
1). Normal Round Shaped Ring 1- Like. 2- Must be. 3- neutral. 4- Dislike. 2). A square Shaped Ring. 1- Like. 2- Must be. 3- neutral. 4- Dislike.
3). Round Shaped Ring with the Interface in another circle. 1- Like. 2- Must be. 3- neutral. 4-Dislike.
Smart Ring Series Material
4). Gold 1- Like. 2- Must be. 3- neutral. 4-Dislike.
5). Silver 1- Like. 2- Must be. 3- neutral. 4-Dislike.
6). Other (Gold/Silver Plated Brass Ring) 1- Like. 2- Must be. 3- neutral. 4-Dislike.

E. Final Design

After following the procedure mentioned above, the design of the series of rings is as follows. Figure 2 will give the final design. Furthermore, the authors are connecting the ring to the users' mobile phone. The user will also get a notification for their phone regarding the ring's updates.



Figure 2: Final Design

F. Survey Results

The objective of this survey was to find out the targeted group and their preferences. For this survey, the authors have selected a random group of people. About 67 participants have provided their responses in this questionnaire.

If we consider the statistics of the responses received, 61.2% of the respondents were in the 20-24 age group, and 50.7% were males. 83.6% of the population have used such smart devices as smartwatches. Because of that, we can assume they have proper knowledge about smart devices. 52.2% of people choosing Rs. 30,000 – Rs. 40,000/= as the value of the smart ring ensures that they are aware of such devices. The majority prefer decent smart rings. An equal percentage prefer silver and brass with gold plated as the colour.

Considering these facts, if we develop 67 smart rings, X is the percentage value of a specific color, and Y is the total number of responses. The following equation was used to determine the types of rings;

$$Equation: 1$$

Further the authors have suggested ten features for the participants of the research. By analysing the responses, they have selected four features and designed four rings. The features were recognized by the types of rings the authors used to analyze in the literature review. When considering the features of the rings, the mostly wanted features were decided. Fifteen smart rings in silver, 15 smart rings in brass with gold plated, 11 smart rings in gold and ten smart rings in brass with silver plated will be sold considering the responses.

5. Discussion

Currently, in the market, there are a variety of smartwatches which can be used to do the same tasks as the smart ring that was proposed, but when analysing deep inside, it is clear that the smart ring has more efficiency, reliability, privacy and is more user-friendly than the smartwatch concept. Though the manufacturing processes of smartwatches and smart rings differ, they use the same sort of sensors. In terms of accuracy, the smart rings are higher than the smartwatches because of their intrinsic form factor design. These sensors perform tasks such as tracking the biometric data, detecting linear acceleration, monitoring rotational movements, and monitoring the user's heart rate. But smartwatches consist of more packed features. The sensors, such as GPS Tracker, are

included in the smartwatches apart from the smart rings. But anyhow, both the smartwatches and smart rings are connected to a mobile app through which the users can log in and collect the relevant data they need. The information gained using the app is always personalized from person to person.

The fingers consist of various arteries and capillaries. These allow smart rings to gather more accurate data than the smartwatches on the wrists. Smartwatches have a greater tendency to expose themselves to natural light and other environmental factors, which can reduce the accuracy of the data. But since smartwatches are placed on the fingers, they are not facing any circumstances like that. Also, the data measured by the smartwatches are considered entirely accurate only if worn tightly on the user's wrist, which is uncomfortable for the user. Smart rings are lightweight and easy to use. So, in terms of comfort, smart rings play a significant role. If the user needs to gather a range of data for a long period, it requires the user to wear the device continuously for a longer period. So, a ring will be the best option to make the user's work easy and comfortable while obtaining accurate results. When considering durability, smartwatches and smart rings do not have much difference. But the strap of the smartwatches wants to last as long as the display, while smart rings would not have such circumstances. Privacy is one of the significant factors that users need to consider when using a wearable smart device that tracks their private details, such as health conditions. So, users must be vigilant that this sensitive data is always under threat. The issue with smartwatches is that they have a display and sometimes speakers that anyone else can view or hear once the user switches on them. But the smart rings usually do not have displays or loudspeakers. But other than that, the privacy factor depends on the user. Since both the smartwatch and smart ring are wearable devices, it is required to consider their battery life. Most fitness and activity smart rings can last for 7 days. But an average smartwatch can only last for 18 hours. It might be because the smartwatches have comparatively bigger screens than smart rings, which consume more battery life. Especially in an era like now, people are very concerned about the pricing of the devices they purchase. The device needs to be worth the price they are paying. Smartwatches indeed consist of comparatively more features than smart rings, but those are more expensive than smart rings. Depending on the model, a quality smartwatch with activity and fitness tracking features costs between \$150 and \$600.

Regardless of wearable technology, the most widely used brands always have higher prices. In contrast, the price of smart rings in the same market might range from \$100 to \$300. If you do not need to display the details you need to measure all the time, the best option is to buy a smart ring because that does the same function for a lower amount of money. So, the factors mentioned above make smart rings a superior choice over smartwatches because of their incredible features. The ring design follows the KE concepts to give the users the best experience. The results of this paper's analysis make it abundantly evident that

analytics information may be used to enhance userfriendliness and customer satisfaction. The main obstacles highlighted by the experts in the sample included a lack of technical professionals, high starting costs, and a lack of technical expertise. However, most respondents thought mobile applications improved the customers' experience.

6. Conclusion

The demonstrated wearable smart ring series can provide accurate and useful data for the users. Wearable technologies have evolved mainly with technological advancements such as Global Positioning Systems, Bluetooth, Wi-Fi, and sensor systems. The author hopes to provide users with a series of smart rings by implementing a smart ring series. The first series shows the fitness level of the user, including temperature, heart rate, oxygen level of blood and calories consumed, while the second series provides features such as unlocking your smartphone and tablet and also closing and unlocking your door. The third series tracks your emotions and stress levels. The fourth series will track movement, which includes walking, running and sleeping. Users of smart rings can customize according to the material, the size of the finger and varied materials available. It will be much helpful to maintain a healthy lifestyle because most people resist doing checkups with their busy lifestyles, so with the smart ring series, maintaining a healthy body has become an easy task for users.

Further, the smart ring is charged using an external port, and the ring is connected to the user's smartphone so that all the notifications and results will be displayed on the screen and can be controlled accordingly. The smart ring series will be helpful in the day-to-day life of a person by making the users lives much easier with its unique features, handy size and user friendliness. Smart rings will have a good market demand in the future with more technological advancements and new features adding up.

A. Future Work

As for further work, the number of features for a ring series will be increased. According to the suggestions received, functions like calling, voice assistance, alerting users when their hands are tired and requesting that they take a break can be included. This will help programmers avoid a repetitive strain injury. Another feature which could be added is to alert people to the power outage time based on where they live so that it would be helpful for them with the current situation in Sri Lanka. Further, planning to make rings with varied materials which are non-rusting, long-lasting and affordable.

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